Heat Loss & Heat Gain

Affordable Comfort Conference
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Rick Karg
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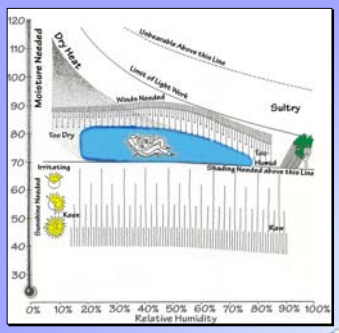
rjkarg@karg.com

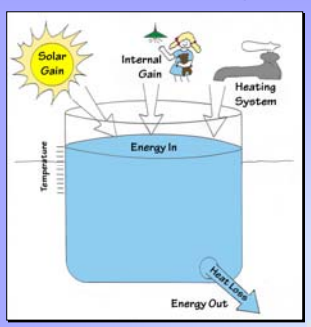
Human Comfort Zone
(After All, it's Humans We're Experimenting With)

Human Comfort Zone

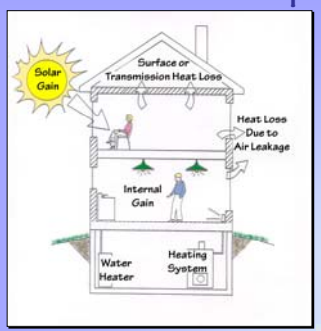


The Bucket Analogy

Bucket Analogy



The Thermal Envelope



Some Terms of Heat Transfer

Heat Transfer Definitions - 1

- Heat energy:
  - Molecular motion, the lowest form of energy.
- Temperature:
  - Assignment of a value to the degree of molecular motion.
- Absolute zero:
  - The temperature at which molecular motion ceases (-460°F).

Click 6

Heat Transfer Definitions - 2

- Temperature difference:
  - Difference between the indoor and outdoor temperatures, often referred to as "delta T".
- British Thermal Unit:
  - The amount of thermal energy required to increase the temperature of one pound of water by one Fahrenheit degree. For the rest of the world, 1 Btu = 1055 Joules.

Click 4

Heat Transfer Definitions - 3

- Internal heat gain:
  - Thermal energy from people and appliances that gives off heat to the indoor environment.
- Surface or transmission heat transfer:
  - Heat transfer through solid building surfaces, including ceilings/roofs, walls, floors, windows, and doors.
- Heat transfer due to air leakage:
  - Results from infiltration and exfiltration.

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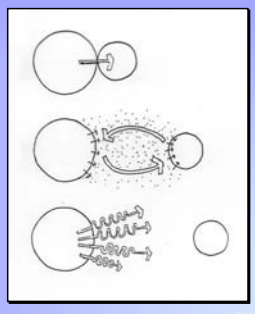
Means of Heat Transfer

Conduction

Convection

Radiation



Transmission or Surface Heat Transfer

Heat Loss and Heat Gain

Transmission or Surface Heat Transfer is Dependent Upon

- Temperature difference between the indoors and outdoors.
- Heat transfer rate through surfaces (R-values or U-values). Surfaces include ceilings/roofs, walls, floors, windows, & doors.
- The size of the surfaces, in ft^2.

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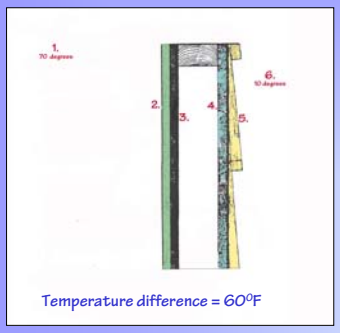
Heat Loss and Heat Gain

Heat Transfer Through a Wall



Heat transfer
- Conduction
- Convection
- Radiation

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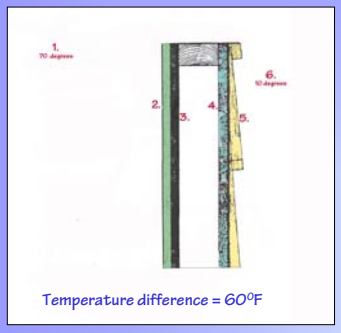
Heat Loss and Heat Gain

Heat Transfer Through a Wall



Heat transfer
- Conduction
- Convection
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Heat Transfer from hot to cold, or high energy to low energy.

Wait 3

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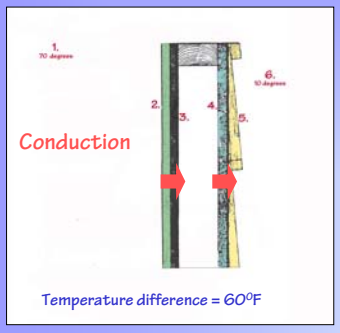
Heat Loss and Heat Gain

Heat Transfer Through a Wall



Heat transfer
- Conduction
- Convection
- Radiation

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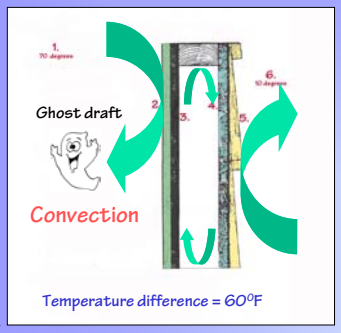
Heat Loss and Heat Gain

Heat Transfer Through a Wall



Heat transfer
- Conduction
- Convection
- Radiation

Click 1

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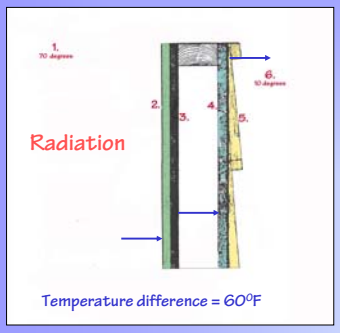
Heat Loss and Heat Gain

Heat Transfer Through a Wall



Heat transfer
- Conduction
- Convection
- Radiation

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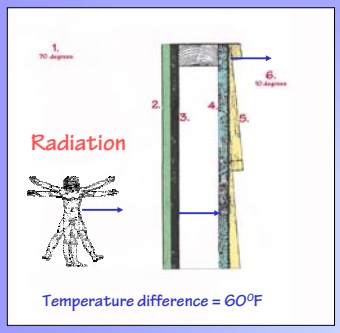
Heat Loss and Heat Gain

Heat Transfer Through a Wall



Heat transfer
- Conduction
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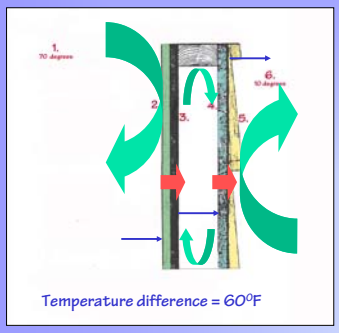
Heat Loss and Heat Gain

Heat Transfer Through a Wall

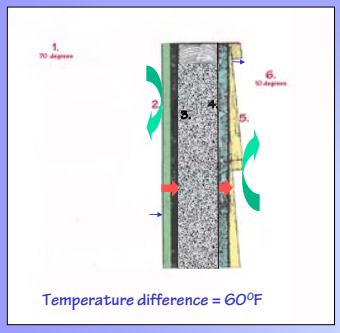


Heat transfer
- Conduction
- Convection
- Radiation

Heat Transfer without insulation

Heat Loss and Heat Gain

Heat Transfer Through a Wall



Heat transfer
- Conduction
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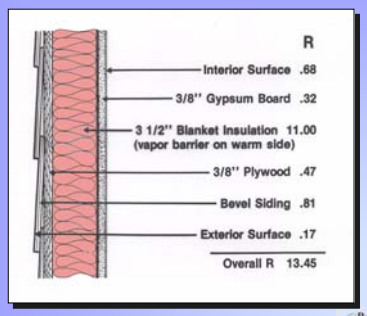
Heat Transfer with insulation

Heat Loss and Heat Gain

Surface Heat Transfer



Heat Loss and Heat Gain

Surface Heat Transfer

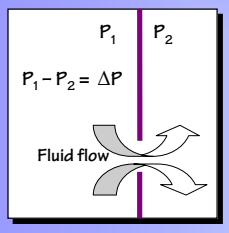
- R-value is the resistance to heat transfer through a building surface. Surfaces include ceilings/roofs, walls, floors, windows, & doors.
- U-value IS the heat transfer through a building surface.
- R=1/U
- U=1/R
- R-values may be added together, U-values may not.

Heat Loss and Heat Gain

The Driving Forces of Air Leakage

What Causes Air-Leakage?

Fluid Flow Through a Hole



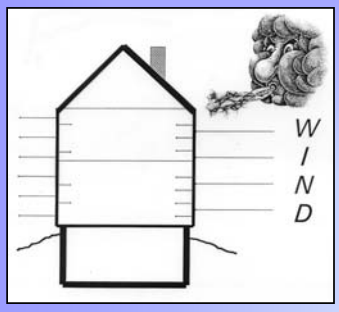
Must have:

1. Hole.
2. Pressure difference.

Drivers can be:

1. Wind.
2. Stack effect.
3. Mechanical forces.

Wind-Driven Air Leakage

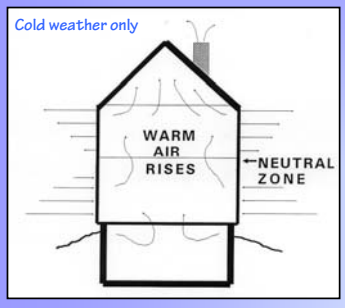


Factors:

- Wind speed.
- Leakage area.

Stack-Effect Air Leakage

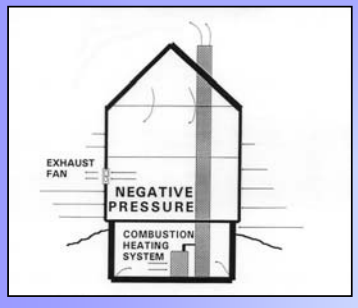
Cold weather only



Factors:

- Temp. difference.
- Leakage area.
- Effective height.

Mechanically-Driven Air Leakage



Factors:

- Leakage area.
- Exhaust fan CFM.
- Heating system.

Heat Transfer Due to Air Leakage

Heat Transfer Due to Air Leakage is Dependent Upon:

- Temperature difference between the indoors and outdoors.
- Cubic feet of air leakage through the house for a given time period. The important part of the house is the above grade volume within the thermal envelope.

Measuring Air Leakage

Measuring Air Leakage

- Blower door testing:
  - Depressurize or pressurize a house to a pressure difference of 50 Pascals and then measure the flow through the blower door fan.
- Air changes per hour (ACH):
  - The number of times one house volume of air leaks through the house in one hour.

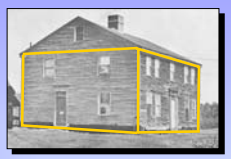
Blower Door Testing

Blower door test results are expressed as CFM_{50} values.

Taking Care of Business in Maine

Air Changes per Hour (ACH)

If this house is 40' x 32' x 16' high, its above-grade volume within the thermal envelope is 20,480 ft^3.



If ACH is 1.0, then 20,480 ft^3 of air moves through the house each hour;

If ACH is 0.75, then 15,360 ft^3 of air; or

If ACH is 0.5, then 10,240 ft^3 of air.

Click 1

Air Changes per Hour (ACH)

ACH is either estimated from a table or calculated with from a blower door CFM_{50} value.

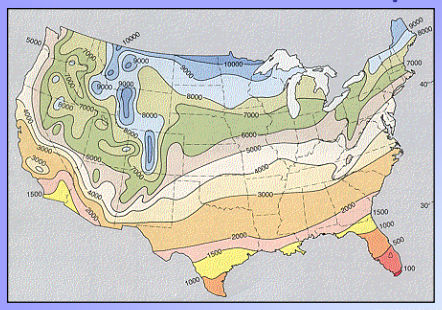
Heat Loss and Heat Gain

Calculating Heat Loss

- To calculate heat transfer in a house, let's say heat loss, we must calculate the surface heat loss through all surfaces of the thermal boundary; and
- Calculate the heat loss resulting from air leakage through the thermal envelope (above grade only).
- Solar gain and internal gain are not losses in this case.

Heat Loss and Heat Gain

Heating Degree Day Map



Heat Loss and Heat Gain

Calculating Heat Gain

- To calculate heat gain in a house we must calculate the surface heat gain through all surfaces of the thermal boundary; and
- Calculate the heat gain resulting from air leakage through the thermal envelope (above grade only).
- Solar gain and internal gain are loads in this case, so they must be considered.

Heat Loss and Heat Gain

Residential Load Calculation for Heating/Cooling System Sizing

- Manual J, 7th edition ($28.00/$48.00).

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www.acca.org.

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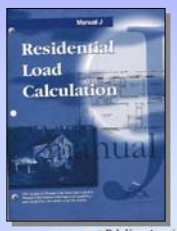

Heat Loss and Heat Gain

Load Calculation Manual

- Manual J, 8th edition ($67.15 member, $152.15 non-member!!).

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